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Addition of three Ascidian species to Indian waters from Andaman and Nicobar Islands

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Abstract

Ascidians are exclusively marine, an invertebrate chordate faunal group commonly known as sea-squirt; found worldwide from intertidal to a greater depth of the ocean. Three species of ascidians, *Polycarpa reniformis* (Sluiter, 1904) and *Cnemidocarpa hemprichi* Hartmeyer, 1916 belonging to the family Styeidae and *Microcosmus bitunicatus* Monniot F. and Monniot C. 2001 belonging to the family Pyuridae of order Stolidobranchia under the class Ascidiacea were recorded from the reef environment and shipwreck area of Andaman and Nicobar Islands first time from Indian waters. Taxonomic characteristics along with their previous distributional range are depicted in the present article.

Keywords: Andaman Islands, India, New records, Sea Squirts

Introduction

Ascidians belong to the Class Ascidiacea under the Subphylum Tunicata and Phylum Chordata. This faunal group is commonly known as sea squirt. The sac-like sessile fauna eject water through their siphons when disturbed. The position of the subphylum in the phylogenetic tree is very important as it represents one of the invertebrate-chordate faunal groups. Researchers established that tunicates are closer to the vertebrates than cephalochordates according to the same gene expression patterns in the embryonic stage of the vertebrates and tunicates (Satoh, 2003). The faunal group also has ecological (Shenkar, 2008; Meenakshi, 2010) and pharmacological importance (Meenakshi, 2010) which makes them much more interesting. Studies on Indian ascidians were initiated in 1915 (Oka, 1915); the study includes the ascidians of Andaman and Nicobar Islands, Gulf of Mannar and Lakshadweep Sea. Later on, several studies have been conducted in Gulf of Mannar (Sebastian and Kurian, 1981; Renganathan and Monniot, 1984; Meenakshi *et al*., 2003; Meenakshi and Senthamarai, 2013) but Andaman and Nicobar Islands remain abandoned up to 2012. In 2012, Venkataraman *et al*., recorded seven species from Andaman and Nicobar Islands. Subsequently, researchers have conducted several studies from Andaman and Nicobar Islands (Ananthan, 2014; Ananthan *et al*., 2015; Mondal *et al.* 2015; 2017a,b,c,d,e; 2018). Class Ascidiacea comprises about 3089 species worldwide (WoRMS). A total of 263 species were reported from Indian waters (Meenakshi and Gomathy, 2018). However, 219 species were recorded from the Coasts of India (Mondal *et al*., 2020) excluding the Andaman and Nicobar Region. Andaman and Nicobar Region represents 76 species of Ascidians to date (Mondal and Raghunathan, 2018). The present article deals with three newly recorded species from Indian water along with their morphological and anatomical characteristics related to taxonomy and their previously recorded distribution across the globe.

Material and Methods

The ascidians were sampled by Self Contained Underwater Breathing Apparatus (SCUBA) diving in various locations of Andaman and Nicobar Islands (Figure 1). Collected ascidians were washed with fresh seawater followed by narcotization with Magnesium Sulphate crystals ($MgSO_4.7H_2O$) and Menthol crystals ($C_{10}H_{20}O$) (Meenakshi *et al.,* 2003). Fully narcotized specimens were preserved in fresh 4% formaldehyde-seawater solution. Under the Labomed CZM4 microscope, dissections of the specimens were carried out and digitized under a Leica M205A stereo zoom microscope. Identification of these three species was made by following Hartmeyer (1916), Kott (1985), Monniot (2002), Millar (1985) and

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Monniot and Monniot (1996; 2001). Identified specimens were registered and deposited in the National Zoological Collections of Zoological Survey of India, Port Blair.

Results

Descriptions along with the distribution of three newly recorded species of Stolidobranchia are given below.

Phylum CHORDATA Haeckel, 1874
Subphylum TUNICATA Lamarck, 1816
Class ASCIDIACEA Blainville, 1824
Order STOLIDOBRANCHIA Lahille, 1886
Family STYELIDAE Sluiter, 1895
Genus ***Polycarpa*** Heller, 1877

1. ***Polycarpa reniformis*** (Sluiter, 1904)

Material examined: 1 ex.: India, Andaman and Nicobar Islands, District South Andaman, Rutland Island, 11°25.112'N; 92°36.535'E, Depth: 7 m, 16.xii. 2016, Coll.: Jhimli Mondal (Reg. No.: ZSI/ANRC – 16552).

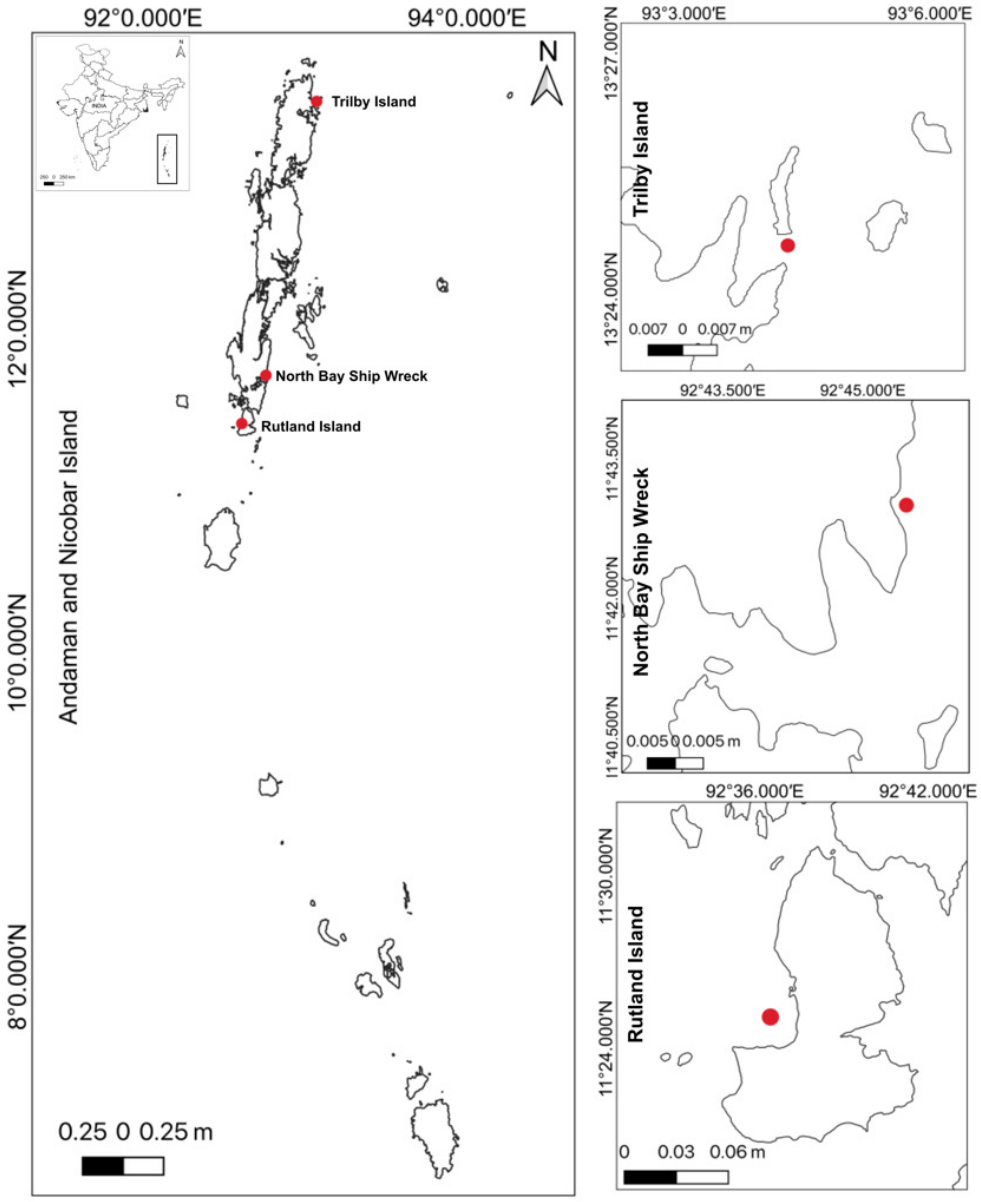

Figure 1. Study areas of Andaman and Nicobar Islands.

Description: The specimen is 3.5 cm long, and elongated in shape (Figure 2a). The tunic is thick, opaque, cartilaginous, soft and brownish. The test surface is with wrinkles and epibionts. The branchial aperture is terminal; both the apertures are very inconspicuous. Apertures are having four lobes on each of them.

Strong muscles are present on the body wall and form a mesh originating from each of the siphons. The prepharyngeal band is narrow. Branchial tentacles are about 100 in number. The dorsal tubercle has an inverted S-shaped opening of the neural gland (Figure 2b). The branchial sac is with four folds on each side of the body (Figure 2c) and 8-10 stigmata are present per mesh (Figure 2d).

Branchial formula: DL 2 (9) 2 (12) 2 (11) 1 (12) 1 E (left side)

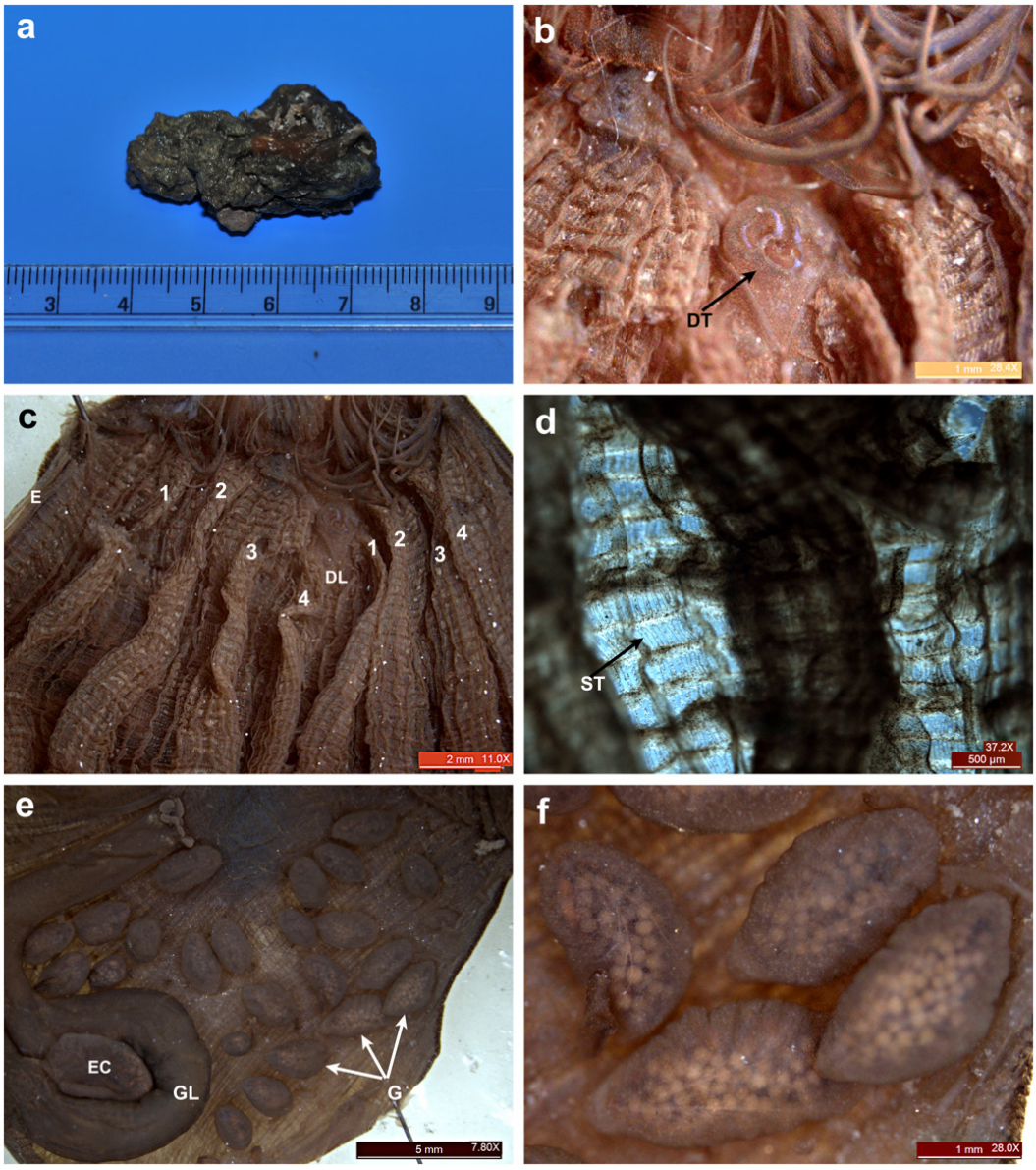

Figure 2. *Polycarpa reniformis* (Sluiter, 1904): **a.** Preserved specimen. **b.** Dorsal tubercle. **c.** Branchial sac with branchial folds. **d.** Stigmata. **e.** Gut loop on the left side of the body along with gonads. **f.** Gonads. (Abbreviation: DL: Dorsal Lamina, DT: Dorsal Tubercle, E: Endostyle, EC: Endocarp, G: Gonad, GL: Gut loop, ST: Stigmata, each number is denoting each branchial fold), (Scale: b– 1mm, 28.4x; c– 2mm, 11x; d– 500µm, 37.2x; e– 5mm, 7.80x; f– 1mm, 28x).

Gut forms a loop (Figure 2e). The stomach is with 20 longitudinal folds internally. The anal border is with 11 irregular lobes (Figure 2e). A single large endocarp is enclosed in the gut loop, no endocarp is found on the body wall. Gonads are spindle-shaped, upright attached to the body wall by a very small ligament at the proximal side of the body as stated by Kott (1985). The rest of the part is free from the body wall (Figure 2f). 24 gonads are found on the right side of the body and 27 on the left side (Figure 2e). Testes are bi or trilobed and arranged in two rows.

Remarks: The species was first reported by Sluiter in 1904 from Indonesia; however, the report on the particular species is scanty. After Sluiter, Kott (1985) reported the species from Australia. Before Kott, one more report has been found from Australia by Hartmeyer and Michelsen, but Kott expresses her doubt that the species found by Hartmeyer and Michelsen is the same as the species found by Kott. Later on, Lee *et al*., (2016) unveil the distribution of present species from Taiwan, which Su recorded in 2013 (Lee *et al*., 2016).

The present species has been identified by its characteristic feature, i.e., delicate body wall, complete opening of a neural gland on the tubercle, single endocarp, and presence of numerous upright gonads on the body wall as stated by Kott (1985).

Distribution: India: Andaman and Nicobar Islands (Figure 1); *Elsewhere*: Australia, and Indonesia (Kott, 1985), Taiwan (Lee *et al*., 2016).

Genus ***Cnemidocarpa*** Huntsman, 1913

2. *Cnemidocarpa hemprichi* Hartmeyer, 1916

Material examined: 2 ex.: India, Andaman and Nicobar Islands, District North and Middle Andaman, Trilby Island, 13°24.577'N, 93°04.226'E, Depth: 7 m, 18. viii.2014, Coll.: Jhimli Mondal (Reg. No.: ZSI/ANRC-16553).

Description: The specimen is 1.2 cm long and 1.5 cm in width, oval and attached by the left side of the body (Figure 3a). The test is thick, cartilaginous and sands thinly cover the surface of the test. Siphons are wart-like structures with four lobes on each of them. Anteriorly the specimen has a salmon pink colour (Figure 3a). Colour persists in preservatives.

The body wall is thin with muscles radiating from each siphon. Both siphons have circular and longitudinal muscles. 21 branchial tentacles are arranged in two-sized order along with 3-4-minute tentacles surrounding the branchial aperture (Figure 3b&c). The prepharyngeal area is narrow, forming v-shaped bending at the position of the dorsal tubercle. The U-shaped opening is found on the dorsal tubercle (Figure 3d). The dorsal lamina is smooth. On each side of the body, four branchial folds are present (Figure 3b). About 10 stigmata are present per mesh. Parastigmatic vessels are also present.

Branchial formula: DL 0 (11) 3 (11) 3 (12) 3 (9) 3 E (left side).

Gut forms a loop (Figure 3e). The stomach is with 26 longitudinal folds internally (Figure 3f). The anal border is smooth. The gut loop encloses small endocarps. Endocarp is also present on the body wall, scattered on both sides of the body. Gonads are long, five are present on the left side and eight are on the right side of the body (Figure 3b & e).

Remarks: In the present species, five gonads are present on the left side and eight are present on the right side of the body. While the species of Monniot C. (2002) consist of smaller number of gonads on both sides, which also matches with the *Cnemidocarpa madagascarensis* Hartmeyer, 1916. *C. madagascarensis* is synonymous with *Cnemidocarpa hemprichi*. However, the original description of *C. hemprichi* Hartmeyer, 1916 supports the presence of more numbers of gonads on both sides of the body. With the description of the species, he illustrates six gonads on the left and nine on the right (Hartmeyer, 1916). Millar (1985) reported *Cnemidocarpa madagascariensis* Hartmeyer var. *regalis* Michelsen, 1922 (which is also synonymous with the present species) with five gonads on the left and nine gonads on the right. Hence, the present species is identified as *C. hemprichii*.

Distribution: India: Andaman and Nicobar Islands (Figure. 1); *Elsewhere:* Red Sea (Hartmeyer, 1916), Madagascar, New Zealand (Millar, 1985), Mauritius and Yemen (Monniot, 2002).

Genus ***Microcosmus*** Heller, 1877

3. *Microcosmus bitunicatus* F. Monniot & C. Monniot, 2001

Material examined: 3 ex.: India, Andaman and Nicobar Islands, District South Andaman, North Bay, 11°43.006′N, 92°45.465′E, Depth: 10 m, 05. viii.2016, Coll.: Tamal Mondal (Reg. No.: ZSI/ANRC – 15345).

Description: Collected specimens are 3.5 cm in length and 4.3 cm in width (Figure 4a). The siphons are divergent

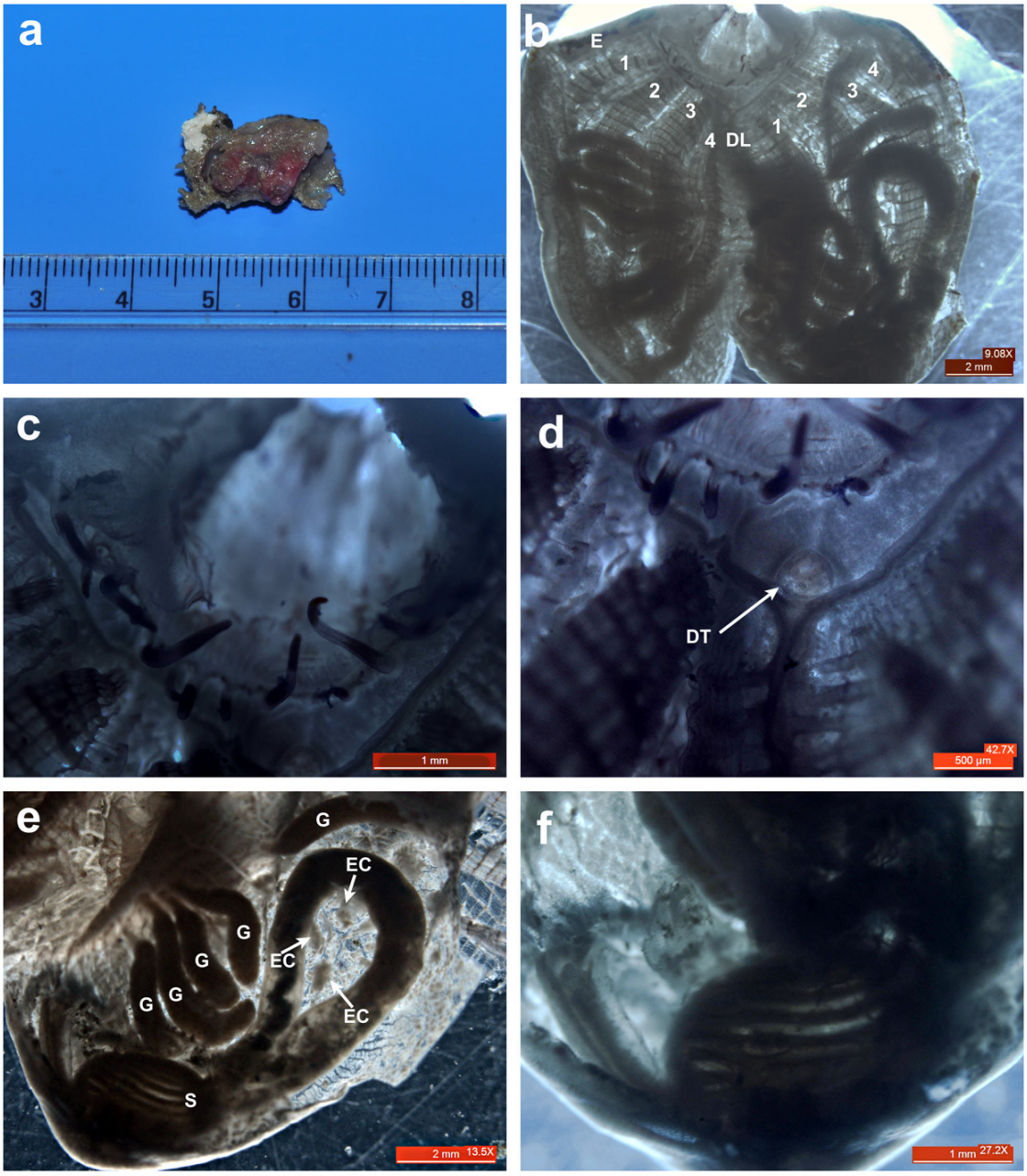

Figure 3. *Cnemidocarpa hemprichi* Hartmeyer, 1916: **a.** Preserved specimen. **b.** Branchial sac with folds. **c.** branchial tentacles. **d.** Dorsal tubercle. **e.** Gut loop on the left side of the body along with gonad. **f.** Stomach. (Abbreviation: DL: Dorsal Lamina, DT: Dorsal Tubercle, E: Endostyle, EC: Endocarp, G: Gonad, S: Stomach, each number denoting each branchial fold), (Scale: b– 2mm, 9.08x; c– 1mm; d– 500µm, 42.7x; e– 2mm, 13.5x; f– 1mm, 27.2x).

from each other. The test is fully covered with muddy and sandy particles with few epibionts. The specimens were located under the boulder at the site of the shipwreck. The species was also searched in the reef area near the shipwreck, but it was not found. The specimen retains its muddy colour after fixation also. All the collected specimens have two tunics (Figure 4b). The internal tunic was also covered by muddy and sandy sedimentation. It also has been found that the internal tunic is attached to the external one at the ventral side with a thick thread-like structure. The internal

tunic is very thin and is of muddy colour.

Body musculature is strong and pyurid type. Both siphons are with strong longitudinal muscles. The prepharyngeal area is papillated. 20 tentacles are arranged in three-sized order. All the tentacles follow 3rd order branching pattern. The dorsal lamina is a smooth and thin membranous structure. The dorsal tubercle is horseshoe shaped with in-rolled coiled horns (Figure 4c). The branchial sac has six folds on each side of the body (Figure 4d). 10 stigmata are present per mesh. Parastigmatic vessels are present.

Branchial formula: DL 3 (26) 6 (27) 4 (22) 4 (21) 3 (21) 4 (16) 1 E (left side)

Gut forms a loop (Figure 4e). The hepatic lobe is large with parallel glandular ridges which consist of small papillae. The anus is bilobed and smooth bordered. Gonad consists of three blocks-like structures on both side of the body, on left the first lobe is enclosed inside the gut loop.

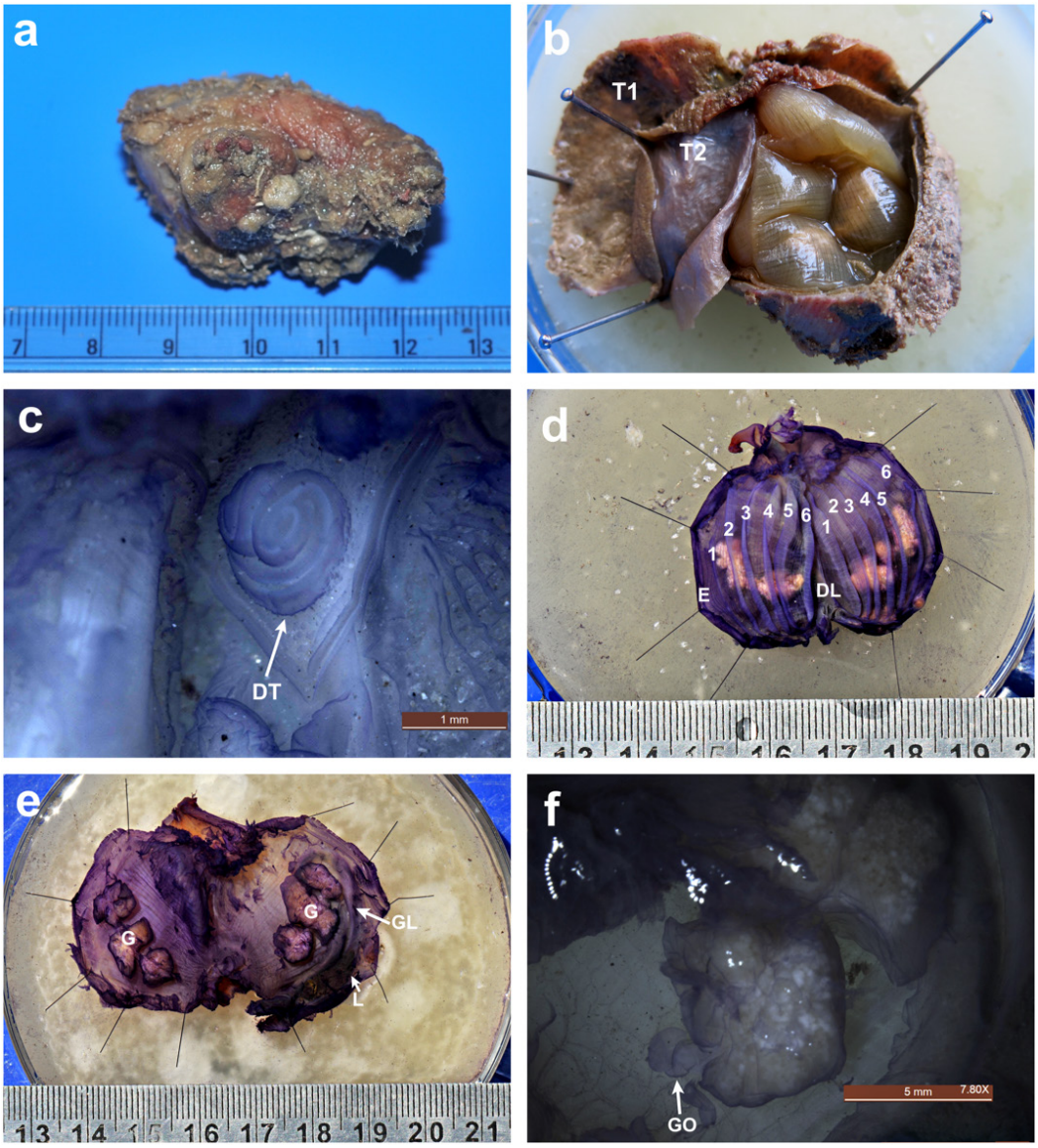

Figure 4. *Microcosmus bitunicatus* Monniot & Monniot, 2001. **a.** Preserved specimen. **b.** Double test. **c.** Dorsal tubercle. **d.** Branchial sac with folds. **e.** Gut loop and gonad in the body wall. **f.** Opening of gonad. (Abbreviation: DL: Dorsal Lamina, DT: Dorsal Tubercle, E: Endostyle, G: Gonad, GL: Gut loop, GO: Opening of Gonad, L: Liver, S: Stomach, T1: First Tunic/Outer tunic, T2: Second Tunic, each number is denoting each branchial fold), (Scale: c– 1mm; f– 5mm, 7.80x).

Gonoduct is short. A gonoduct opening is a simple hole, with a membrane-like structure, that opens at the base of the siphon (Figure 4f).

Remarks: The closest species to *Microcosmus bitunicatus* is *Microcosmus manaarensis*, which also has two layers of tunics. But the tunics of *Microcosmus mannarensis* contain one normal internal tunic and the external one is made up of a network of ramified hairs shielded by sediment agglomeration (Monniot F. and Monniot C., 2001). The internal tunic is linked to the external one with the tunic vessels as stated by Monniot and Monniot (1996). In 1996, Monniot F. and Monniot C. examined the species from the Philippines but identified it as *Microcosmus mannarensis*. However, in 2001 they confirmed that the specimen was wrongly identified after obtaining the second specimen, and they described both specimens as new species, which they named *Microcosmus bitunicatus* (Monniot F. and Monniot C., 2001).

Distribution: India: Andaman and Nicobar Islands (Figure 1); *Elsewhere*: Philippines (Monniot F. and Monniot C., 1996, 2001).

Discussion

The taxonomic literature on ascidians is scanty for the Andaman and Nicobar Islands (Mondal and Raghunathan, 2018). Researchers are considering the fauna as lesser-known (Mondal *et al*., 2015) from the Indian context. In the present study, among the three species of ascidians, two species *Polycarpa reniformis* and *Cnemidocarpa hemprichi* are collected from the natural reef areas of the Andaman and Nicobar Islands, while *Microcosmus bitunicatus* is collected from the shipwreck of North Bay, South Andaman which is now turning into an artificial reef (Mondal and Raghunathan, 2017). However, the natural reef of North Bay is located just beside the shipwreck. *Micorcosmus bitunicatus* is only recorded from Cebu, Philippines (Monniot F. and Monniot C., 1996; 2001), no other records of the particular species have been found. However, it is very difficult to conclude whether the species was endemic to the Philippines or not, because of the lesser exploration of the ascidian fauna. For the same reason, determining the status of the species, whether it is native or non-native, is difficult in the presently recorded area. There is no record of the spread of *Microcosmus bitunicatus* due to seaway movement across the globe or any parts of the globe, but due to the nature of biofouling of the faunal group (Lambert, 2002; Shenkar, 2008; Rocha *et al*., 2009), this probability cannot be omitted without further biological and ecological studies on the particular species. Furthermore, studies need to be conducted on each species recorded from the Andaman and Nicobar Islands to establish their native and non-native status as the continuous exploration of ascidians from the area has been started recently (Mondal and Raghunathan, 2018). Extensive surveys are required to explore the ascidians of Andaman and Nicobar Islands as well as to understand their importance in the particular region for conservation and management purposes.

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References

Ananthan, G. 2014. Diversity and ecology of sedentary ascidians of the Great Nicobar biosphere reserve. *First Year Progress Report*, 1-103.

Ananthan, G., Stalin, C. and Raghunathan, C. 2015. A new record of ascidians in Indian waters, from the Great Nicobar Biosphere Reserve, Andaman and Nicobar Islands. *Marine Biodiversity Records*, **8**: 1-5. https://doi.org/10.1017/S1755267215000937

Hartmeyer, R. 1916. Neue und alte Styeliden aus der Sammlung des Berliner Museums. *Mitt zool Mus Berlin*, **7**: 205-231.

Kott, P. 1985. ThThe Australian ascidiacea, Part 1, Phlebobranchia and Stolidobranchia. *Memoirs of Queensland Museum*, **23**: 1-438.

Lambert, G. 2002. Nonindigenous ascidians in tropical waters. *Pacific Science*, **56**(3): 291-298. https://doi.org/10.1353/psc.2002.0026

Lee, SS-C., Chan, JY-H., Teo, SL-M. and Lambert, G. 2016. State of knowledge of ascidian diversity in South China Sea and new records for Singapore. *Raffles Bulletin of Zoology*, *Supplement No.,* **34**: 718-743.

Meenakshi V.K. and Gomathy S., 2018. Indian ascidians over the hundred years- A checklist. *Research Journal of Life Sciences, Bioinformatics, Pharmaceutical and Chemical Sciences*, **4**(6): 134-170.

Meenakshi, V. K., Renganathan, T. K., Sentharamarai, S. and Jeyalakshmi, J. 2003. Marine biodiversity- taxonomy of Indian ascidians. *Technical Report*, 1-38.

Meenakshi, V.K. and Senthamarai, S. 2013. On the occurrence of one new species and three new records of the genus *Aplidium* from Indian waters. *Journal of Chemical, Biological and Physical Sciences*, **3**(4): 2712-2721.

Meenakshi, V.K., 2010. Indian ascidians- Potential candidate for research- A review. *IJBT*, **1**(Special Issue): 29-33.

Millar, R.H. 1985. The marine fauna of New Zealand: Ascidicea. *New Zealand Oceanographic Institute Memoir*, **85**: 117.

Mondal, J. and Raghunathan, C. 2018. Ascidians. Chapter 42: 423-431. In: Chandra, K. and Raghunathan, C. (Eds.), Faunal diversity of Biogeographic zones: Islands of India. (Published by the Director, Zool. Surv. India, Kolkata).

Mondal, J., Mondal, T. and Raghunathan, C., 2020. Chordata: Tunicata: Ascidiacea. Chapter **53**: 643-654. Chandra, K., Raghunathan, C. and Mondal, T. (Eds.), Faunal Diversity of Biogeographic Zones: Coasts of India. (Published by the Director, Zool. Surv. India, Kolkata).

Mondal, J., Raghunathan, C. and Chandra, K. 2017d. A new species of Ascidiacea (*Herdmania andamanensis* sp. nov.) from Andaman and Nicobar Islands, India. *Zootaxa*, **1286**(3): 445-450. https://doi.org/10.11646/zootaxa.4286.3.13

Mondal, J., Raghunathan, C. and Mondal, T. 2015. Diversity and distribution of common ascidians of Andaman Group of Islands. *Middle-East Journal of Scientific Research*, **23**(10): 2411-2417.

Mondal, J., Raghunathan, C. and Mondal, T. 2017c. A new species of sea-squirt *Rhopalaea bilobata* (Ascidiacea: Diazonidae) from the Andaman Islands, India. *Threatened Taxa*, **9**(5): 10187-10193. https://doi.org/10.11609/jott.2620.9.5.10187-10193

Mondal, J., Raghunathan, C. and Venkataraman, K. 2017b. New records of A*plousobranch ascidians* to Indian waters from Andaman Islands. *Threatened Taxa*, **9**(2): 9874-9880. https://doi.org/10.11609/jott.1876.9.2.9874-9880

Mondal, J., Raghunathan, C., Mondal, T. and Chandra, K. 2017a. Reef associated ascidians of Andaman and Nicobar Islands. Records of the Zoological Survey of India, Occasional Paper No., **384**: 1-108+32 plates (Published by the Director, Zoological Survey of India, Kolkata).

Mondal, J., Raghunathan, C., Mondal, T. and Chandra, K. 2017e. New record of four *Aplousobranch ascidians* to Indian Waters from Andaman and Nicobar Islands. *Journal of the Marine Biological Association of India*, **59**(1): 82-86. https://doi.org/10.6024/jmbai.2017.59.1.1913-12

Mondal, J., Raghunathan, C., Mondal, T. and Venkataraman, K., 2015. Diversity of Protochordates in India. Chapter 25: 375-399. In: Venkataraman, K., Raghunathan, C., Mondal, T., Raghuraman, R., (Eds.), Lesser known marine animals of India. (Published by the Director, Zool. Surv. India, Kolkata).

Mondal, T. and Raghunathan, C. 2017. Shipwrecks in Andaman and Nicobar Islands: An artificial habitat for corals. *Journal of Marine Biological Association of India*, **59**(2): 92-101. https://doi.org/10.6024/jmbai.2017.59.1.1913-12

Monniot, C. 2002. *Stolidobranch ascidians* from the tropical western Indian Ocean. *Zoological Journal of the Linnean Society*, **135**: 65-120. https://doi.org/10.1046/j.1096-3642.2002.00017.x

Monniot, F. and Monniot, C. 1996. New collections of ascidians from the western Pacific and southeastern Asia. *Micronesica*, **29**: 133-279.

Monniot, F. and Monniot, C. 2001. Ascidians from the tropical western Pacific. *Zoosystema*, **23**: 201-383.

Oka, A. 1915. Report upon the Tunicata in the collection of the Indian Museum. *Memoirs of the Indian Museum*, **6**: 1-34.

Renganathan, T.K. and Monniot, F., 1984. Additions to the ascidian fauna of India. *Bull. Mus. Natn. Hist. nat., Paris*, **6**(2): 257-262.

Rocha, R.M., Kremer, L.P., Bapista, M.S. and Matri, R. 2009. Bivalve cultures provide habitat for exotic tunicates in southern Brazil. *Aquatic Invasion*, **4**(1): 195-205. https://doi.org/10.3391/ai.2009.4.1.20

Satoh, N. 2003. The ascidian tadpole larva: Comparative molecular development and genomics. *Nat Rev Genet*, **4**: 285-295. https://doi.org/10.1038/nrg1042 PMid:12671659

Sebastian, V.O. and Kurian, C.V., 1981. Indian Ascidians. Oxford & IBH Publishing Co., pp. 163.

Shenkar, N. 2008. Ecological aspects of the ascidian community along the Israeli coasts. PhD Thesis. Tel-Aviv University, Israel. pp. 122.

Venkataraman, K., Raghunathan, C., Raghuraman, R. and Sreeraj, C.R. 2012. Marine biodiversity in India. Published by Director, Zoological Survey of India, Kolkata, 1-168.

WoRMS Editorial Board 2022. World register of marine species. Available from https://www.marinespecies.org/aphia.php?p=browser&id[]=2&id[]=1821#focus Accessed 2022-03-02. DOI: 10.14284/170.